Seasonal adjustment of the causes of changes in the domestic money supply

den Butter, F.A.G.; Hogeweg, G.P.J.

published in
De Nederlandsche Bank N.V., Quarterly Statistics
1980

SEASONAL ADJUSTMENT OF THE CAUSES OF CHANGES IN THE DOMESTIC MONEY SUPPLY

This article by F.A.G. den Butter and G.P.J. Hogeweg describes the revised method of seasonal adjustment of the changes in the domestic money supply and their causes, as it is used from now on in the monetary analysis of the Netherlands Bank. This method adjusts all relevant series in a uniform way and makes the seasonally adjusted figures of the causes of the changes in the money supply sum to the adjusted change in the money supply itself.

1. The problem

The monetary analysis of the Netherlands Bank distinguishes four main sources or "causes" of the changes in the domestic money supply, viz. liquidity creation on behalf of public authorities, liquidity creation arising from the net money-creating operations of the banks and giro institutions, inflows of liquidity from abroad to the non-monetary sectors – the so-called national liquidity surplus – and finally "Miscellaneous". These are the relevant changes in the counterparts of the domestic money supply in the aggregated balance sheet of the money-creating institutions; the four respective counterparts are public-authority floating debt, the so-called net money-creating operations, the net foreign assets (including the official gold and foreign exchange holdings of the Netherlands Bank) and the balance of various assets and liabilities of banks and giro institutions. The last counterpart is mainly composed of items in transit (float) and of aggregated net profit of the banks.

In its Quarterly Statistics the Netherlands Bank publishes seasonally adjusted data on the causes of changes in the domestic money supply (Table 4.1). Obviously, the analysis of monetary trends within the year is based on seasonally adjusted figures. Since 1973 the Bank has adjusted financial series for seasonal variations by means of the Census X-11 method. A comparative study [1] conducted by the Bank at that time proved this method to be the most satisfactory.

The changes in the domestic money supply and their causes – here labelled for short as the causes of money growth – have so far not all been adjusted for seasonal variations in a uniform manner. The Bank aimed at the most plausible system of seasonal adjustment for each item separately. The adjustment of the money growth was based on the level of the **total** domestic money supply; however, the adjustment of three of the four causes of money growth was made on a disaggregated basis. As to the net money-creating operations, only (the levels of) those items were adjusted which showed a significant seasonal pattern [2]. In the

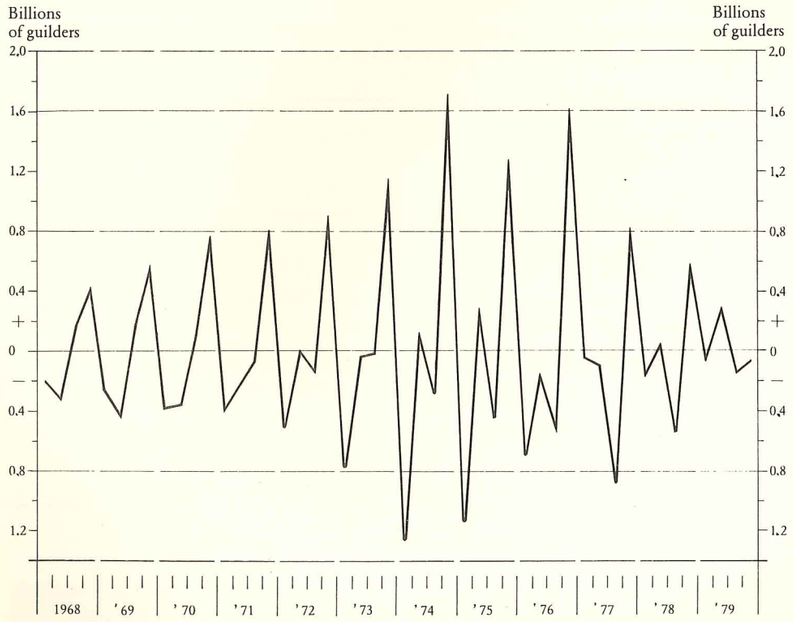
[1] Fase, M.M.G., J. Koning and A.F. Volgenant, "An experimental look at seasonal adjustment", De Economist 121, 1973, pp. 441-480.

[2] Of the nine items into which the net money-creating operations were disaggregated, four did not exhibit a significant seasonal pattern, viz.: capital market funds raised by money-creating institutions other than universal banks, long-term savings certificates to bearer, long-term deposits and bank premises.

case of liquidity creation on behalf of public authorities, until 1979 the adjustment was made to the level of floating debt; it was then replaced by an adjustment of flows, i.e. public-authority expenditure and public-authority revenue. The adjustment of the national liquidity surplus was carried out on flows, viz. the receipts and payments on the current account of the balance of payments on a cash basis; capital transactions were left unadjusted on account of their less significant seasonal pattern. As to the cause "Miscellaneous" an adjustment of levels was applied without disaggregation.

Independent seasonal adjustment of each of a number of interrelated series leads to discrepancies in the seasonal components. The resulting difference between the sum of the seasonally adjusted causes of money growth and the seasonally adjusted money growth itself was traditionally included as a residual entry in the cause "Miscellaneous". As a result of the disaggregation and the adjustment of both levels and flows this residual entry still exhibited a marked seasonal pattern. Chart 1, in which this is depicted for the period 1968-1979, also shows that the residual entry became rather large from time to time, thus hampering an adequate insight into the movements in the various causes of money growth. The lack of uniformity also encouraged a tendency to adapt the method of adjustment in an *ad hoc* manner to the plausibility of the outcome.

Chart 1 **Size of the residual entry in the seasonally adjusted figures of Table 4.1 (old method of seasonal adjustment)**



In order to meet the various objections the revised method, within the framework of the Census X-11, adjusts all causes of money growth in a uniform way and in conformity with the adjustment of the money supply. This results in a substantial reduction in the seasonal pattern of the residual entry. However, the discrepancy between the seasonal components cannot be eliminated completely as is discussed in sections 2 and 3.1 below. In addition, section 2 sets out a procedure to distri-

bute the residual entry among the various causes of money growth. The results given by the revised method are considered sufficiently satisfactory to warrant application in the years ahead.

2. Procedure of distributing the residual entry

Most methods of seasonal adjustment do not automatically meet the requirement that the sum of the seasonally adjusted parts be equal to the seasonally adjusted total. Mathematically speaking, this is due to the fact that most methods of adjustment, and especially the more advanced ones, such as Census X-11, are not linear operators[3]. Consequently, there is a residual entry or balancing problem. In principle, the procedure, described in this section, to distribute the residual entry among the adjusted series can be used in conjunction with any method of seasonal adjustment, provided that the method breaks down the original series (X) into three components, viz. a trend-cycle component (TC), a seasonal component (S) and an irregular component (I). In the case of additive adjustment, $X = TC + S + I$, with $X - S$ (=TC + I) representing the seasonally adjusted series. Multiplicative adjustment employs a seasonal index s and an irregular index i, so that $X = TC.s.i.$, with $S = [(s - 1)/s]X$ representing the seasonal component, $I = (i - 1).TC$ the irregular component and $X - S$ (=TC.i) again the seasonally adjusted series.

The procedure of distributing the residual entry serves to make the seasonally adjusted series sum to the seasonally adjusted total. This means that the adjustment terms are bound to constraints. The **first** constraint is that the adjustment terms in any observation period must sum to the residual entry. If it is assumed that there are four sub-series j, and that quarterly figures are used, this first constraint becomes:

$$\sum_{j=1}^{4} C_{jk} = V_k \qquad \text{for } k = 1, \ldots, 4 \qquad (2.1)$$

where V_k is the residual entry in the k^{th} quarter of the observed year and C_{jk} represents the adjustment terms for the j^{th} sub-series.

Furthermore, the adjustment terms for each sub-series must sum to zero over the year, so as to ensure that after distribution of the residual entry the sum of the quarterly figures for each series is equal to the annual total[4]. Consequently, the **second** constraint is:

$$\sum_{k=1}^{4} C_{jk} = 0 \qquad \text{for } j = 1, \ldots, 4 \qquad (2.2)$$

[3] A method of adjustment M is a linear operator if for two series A and B, M(A) + M (B) = M (A+B), with M(Y) representing the adjusted series Y.

[4] If the multiplicative variant of Census X-11 is used or in case of adjustment of levels, the seasonally adjusted series do not automatically sum to their annual total. Hence, the difference between the annual total and the sum of the seasonally adjusted quarterly figures is distributed evenly among the quarterly figures. Hitherto this was not done for the money growth itself, the advantage being that the percentage change in the seasonally adjusted liquidity ratio (M_2 as a percentage of net national income) follows from the percentage changes in the seasonally adjusted money supply and in national income. However, in view of constraints (2.1) and (2.2), it is necessary, when using the procedure of distributing the residual entry, that the seasonally adjusted money growth figures also sum to the annual total.

Table 1 **Schedule for distributing the residual entry among the four causes of money growth**

Description	Year				Total
	I	II	III	IV	
Liquidity creation on behalf of public authorities	C_{11}	C_{12}	C_{13}	C_{14}	0
Change in net money-creating operations	C_{21}	C_{22}	C_{23}	C_{24}	0
National liquidity surplus	C_{31}	C_{32}	C_{33}	C_{34}	0
Miscellaneous	C_{41}	C_{42}	C_{43}	C_{44}	0
Residual entry	V_1	V_2	V_3	V_4	0

The schedule in Table 1 shows that constraints (2.1) and (2.2) imply that the residual entries sum to zero over the year:

$$\sum_{k=1}^{4} V_k = 0$$

It is obvious that the distribution should be made in such a way that, under the above constraints, the adjustment terms are as small as possible. Therefore the weighted sum of squares of the adjustment terms

$$\sum_{j=1}^{4} \sum_{k=1}^{4} w_{jk} C_{jk}^2 \qquad (2.3)$$

is taken as the criterion value. Here the weights w_{jk} are inversely proportionate to the product of the standard deviation of the seasonal component (σ_S) and the irregular component (σ_I) of cause j in the k^{th} quarter:

$$w_{jk} = \frac{1}{(\sigma_S \, \sigma_I)_{jk}} \qquad (2.4)$$

Minimization of (2.3) under constraints (2.1) and (2.2) produces (in this case) 16 adjustment terms $C_{jk}(j, k = 1, \ldots, 4)$[5].

The standard deviations of the seasonal component (σ_S) and of the irregular component (σ_I) required for these weights are calculated for the past eight years. As a result, in the procedure of distribution of the residual entry, a (slightly) changing set of weights is used each individual year[6].

In the above weighting, the adjustment terms are positively correlated with the variability in the seasonal component and the irregular component in the rele-

[5] *Mutatis mutandis* the same reasoning applies to monthly figures.
[6] For the first eight years of the sample period of this study the same weights were used.

vant quarter. Thus a series which exhibits great variability in seasonal and irregular fluctuations in a certain quarter is allocated a relatively large share of the residual entry for that quarter. The underlying reasoning is that the measurement of seasonality becomes less accurate as the variability of the seasonal and irregular components becomes larger. It seems proper to allocate a larger share of the residual entry to such a series rather than to a series which exhibits hardly any variability in its seasonal fluctuations or its irregular component.

It must be pointed out that this distribution procedure is not sustained by any formal theory, but that it is based solely on the practical considerations set forth above [7]. In actual practice, this method, which has been derived from procedures used by the Federal Reserve and the Bank of England [8], proves quite satisfactory. The Federal Reserve and the Bank of England employ the distribution procedure to make their seasonally adjusted flow-of-funds tables internally consistent. Just as in those tables, our distribution problem concerns a coherent matrix (see Table 1), in which it is desirable for the seasonally adjusted quarterly figures to sum to the annual figure.

In the calculation and in the notation used in this section, we have deliberately chosen to distribute the residual entry among the four causes of money growth. An alternative in which part of the residual entry is allocated to the growth of the money supply itself has also been tried, but from a theoretical viewpoint to include the money supply in the distribution of the residual entry does not seem correct. Hence, upon reflection, this alternative was rejected [9].

3. Seasonal adjustment of the causes of money growth [10]

3.1. Old method

In the analysis of seasonal fluctuations by means of the Census X-11 method, two key figures are of major importance, viz. the $\overline{I}/\overline{S}$ ratio and the value of the F statistic. Although no formal statistical significance can be attached to these figures in the Census X-11 method, they are used in actual seasonal adjustment practice as indicatory yardsticks. The $\overline{I}/\overline{S}$ ratio reflects the average proportion between the irregular component and the seasonal component. The estimate of the seasonal component is considered more reliable as the $\overline{I}/\overline{S}$ ratio is lower. The computed F ratio gives an indication of the share of seasonality in the variance of the series. Subject to certain assumptions, it may serve to establish the significance of the seasonal pattern [11].

For the twelve-year period 1968-1979, the residual entry resulting from the seasonal adjustment method hitherto applied in the monetary analysis has an $\overline{I}/\overline{S}$ ratio of 0.5 and an F ratio of 8.0, which point to a highly significant seasonal pattern (see Table 2). As the residual entry has both positive and negative values, the above figures are based on an additive adjustment. In order to trace this seasonal

[7] Moreover, such a formal theory is barely conceivable within this framework. Consequently, we shall not prove on theoretical grounds that the procedure chosen by us is preferable to other variants.
[8] See "Flow of funds seasonally adjusted", Federal Reserve Bulletin 48 (November 1962), pp. 1393-1407, and "An introduction to flow of funds accounting: 1952-70", Bank of England (1972).
[9] It might be noted that this alternative does not result in any spectacular changes in the movements in the seasonally adjusted series after distribution of the residual entry; each of the causes of money growth is allocated a slightly smaller part of the residual entry.
[10] All calculations in the analysis given in this and the following sections are based on monthly figures; in presenting results, however, we have confined ourselves to quarterly figures, in line with the procedure used in the Bank's Quarterly Statistics.
[11] See J. Shiskin, A.H. Young and J.C. Musgrave, 1965, "The X-11 Variant of the Census Method II Seasonal Adjustment Program", Technical paper no. 15, Bureau of the Census, p. 59.

pattern of the residual entry, the adjusted causes of money growth were investigated for residual seasonality. To that end, series of levels were constructed for these adjusted causes. They were again seasonally adjusted - but now invariably using the multiplicative method. The resulting $\overline{I}/\overline{S}$ and F ratios are also shown in Table 2 (segment B). The fact that the $\overline{I}/\overline{S}$ ratios are in excess of 1 means that for all causes the irregular movements are, on average, larger than the residual seasonality. Nevertheless, the F ratios do indicate that, both for liquidity creation on behalf of public authorities and for the national liquidity surplus, there is still a distinct residual seasonal pattern.

In view of this we again calculated the residual entry after this second round of seasonal adjustment. As indicated by the F ratio of 5.4, its seasonal pattern is still significant, albeit much less so than initially, when the F ratio was 8.0. Nevertheless, this indicates that in the Census X-11 method residual seasonality in the residual entry is unavoidable. One explanation may be that, in disaggregation, shifts occur between the seasonal component on the one hand and the irregular and trend-cycle components on the other. In other words, specific movements which are considered seasonal in the adjustment of the aggregate money supply are allocated to the irregular or the trend-cycle component in the adjustment of the individual counterparts and conversely.

From this analysis it follows – and this conclusion is borne out by the rest of our study – that the residual seasonality in the residual entry generally becomes larger with increasing disaggregation [12]. It would therefore seem advisable to limit disaggregation as much as possible.

Table 2 **Analysis of residual seasonality in the causes of money growth and in the residual entry**

Description	$\overline{I}/\overline{S}$	F	Significant residual seasonality present at a 99% confidence level
A Residual entry, first round	0.5	8.0	Yes
B Liquidity creation on behalf of public authorities	1.5	2.6	Yes
Change in net money-creating operations	1.7	1.1	No
National liquidity surplus	1.2	4.7	Yes
Miscellaneous	2.3	0.9	No
C Residual entry, second round	0.6	5.4	Yes

Explanatory note: Based on monthly figures for the twelve-year period 1968-1979.

3.2. Revised method

Given this starting point two questions remain to be resolved within the framework of the Census X-11 method:

[12] The study by Fase *et al* mentioned in footnote 1 shows that the Census X-11 method is almost idempotent so that the seasonal pattern in the residual entry can indeed be ascribed to disaggregation.

a) should levels or flows be adjusted? and
b) should the additive or the multiplicative version of the Census X-11 method be applied?

As to the choice between adjustment of levels and adjustment of flows, both theoretical and practical considerations lead to a preference for adjustment of levels as far as the money supply is concerned. Seasonal factors are among the determinants of the demand for money and it is usual in the literature (and tenable within the framework of the portfolio theory) that demand-for-money functions are specified in levels [13]. Once it has been decided to carry out the adjustment of the money supply on the basis of levels, it is logically necessary to do the same for the four different causes of money growth, and hence to adjust the counterparts of the money supply in the aggregated balance sheet of the money-creating institutions.

As is known, the choice between additive and multiplicative adjustment is a purely technical matter, which can in principle be made with the aid of an objective criterion. If, in absolute terms, the seasonal and irregular movements of a series are a function of the trend of that series, multiplicative adjustment is called for. On the other hand, if the seasonal and irregular movements are independent of the trend, the series should be adjusted additively.

In order to make this choice between additive and multiplicative adjustment, a number of simple regressions were run for the money supply and its four counterparts. For each series, the absolute value of the difference between the series and its centred 12-month moving average was correlated with this moving average. For series X this equation reads as:

$$|X - X_{12}| = \alpha + \beta X_{12} \qquad (3.1)$$

where X_{12} is the centred 12-month moving average. The term $X - X_{12}$ represents the deviation from the trend (and hence the seasonal and irregular movements). A significant value of the constant term α indicates an additive seasonal pattern, whereas a significant estimate of coefficient β of the trend term indicates a multiplicative pattern. If both α and β are significant, there is a mixed additive-multiplicative pattern.

The results of the trend regressions are shown in Table 3. They suggest multiplicative adjustment of the money supply and all counterparts, except public-authority floating debt. As regards the money supply, the net money-creating operations and the miscellaneous items, there can be little doubt about this choice for a multiplicative adjustment. After all, these are series which increase steadily in a growing economy and with inflation, while apparently the seasonal and irregular movements also increase. However, such an interpretation may not be quite adequate for net foreign assets and public authority floating debt, as we shall see.

In order to obtain an impression of the magnitude of the relevant seasonal and irregular movements, the average absolute values of the deviations from the trend $X - X_{12}$ have been calculated for the entire sample period and for three equal sub-periods. The results are presented in Table 4, which shows that, like the other counterparts, net foreign assets and to a lesser extent public-authority floating debt show increasing seasonal and irregular movements in the sample period. In a

[13] See e.g. M.M.G. Fase and J.B. Kuné, "De vraag naar liquiditeiten in Nederland, 1952-1971", De Economist 122, 1974, pp. 326-356, and F.A.G. den Butter and M.M.G. Fase, "The demand for money in EEC Countries", 1981, to be published in the Journal of Monetary Economics, and the literature cited in the latter article.

Table 3 **Estimation of the trend regressions in order to choose between additive and multiplicative seasonal adjustment**
(millions of guilders)

Description	Constant (α)	Trend coefficient (β)
Money supply	−268 (1.24)	0.025 (7.39)
Public-authority floating debt	1,194 (4.71)	−0.003 (0.14)
Net money-creating operations	−95 (0.95)	0.023 (8.57)
Net foreign assets	−63 (0.88)	0.022 (6.21)
Miscellaneous items (net)	15 (0.40)	0.149 (9.17)

Explanatory note: Based on monthly figures for the twelve-year period 1968-1979. The t-values are shown in parentheses.

nominally growing economy this increase is likely to continue. In that case a multiplicative adjustment of net foreign assets may give rise to problems in situations of persistent balance-of-payments deficits, as in such a situation the net foreign assets will no longer increase, but, on the contrary, decrease. A similar situation most probably accounts for the coefficient of the trend term equalling zero for public-authority floating debt. In the period 1971-1974 a substantial destruction of liquidity took place, which caused the floating debt to decrease. Nevertheless, because multiplicative adjustment is to be preferred for the money supply, the net money-creating operations and the miscellaneous items, it was decided that, for the sake of uniformity, the remaining two counterparts, too, should be adjusted by the multiplicative method [14].

Table 5 presents the $\overline{I}/\overline{S}$ and the F ratios, as discussed in section 3.1, for the multiplicative method chosen, hereafter referred to as the standard method. The Table shows that, in view of the $\overline{I}/\overline{S}$ ratios smaller than one and the high F ratios, a clear seasonal pattern is apparent in three counterparts, viz. public-authority floating debt, net money-creating operations and the miscellaneous items. The same is true of the total money supply. However, the seasonal pattern of net foreign assets is much less clear, although the F ratio of 2.7 still indicates significant seasonality at a 99% confidence level [15].

[14] Additive adjustment has also been investigated for these two counterparts. Results as regards public-authority floating debt are reported in the Appendix. In the case of net foreign assets, the results given by multiplicative and additive adjustment do not differ much in the sample period. The potential problems of multiplicative adjustment of this item do not make themselves felt in the sample period, but may do so in the future.
It might be noted here that adjustment of (net) flows by the multiplicative method is not possible, because both total liquidity creation and the causes of money growth sometimes assume negative values. Considering the increasing deviations from the trend, which occur here, too, and which in the case of additive adjustment cannot be taken to be proportional to a rising trend, this is an additional reason not to adjust flows but to adjust levels.
[15] In the case of additive adjustment, this seasonal pattern is somewhat more pronounced, as evidenced by an F ratio of 4.4.

Table 4 **Average absolute values of the deviations from the trend**
(millions of guilders)

Description	1968-1979	1968-1971	1972-1975	1976-1979
Money supply	1,231	622	1,248	1,924
Public-authority floating debt	1,163	785	1,324	1,416
Net money-creating operations	667	263	561	1,265
Net foreign assets	356	171	278	663
Miscellaneous items (net)	294	107	282	529

A notable result is the F ratio of 3.4 for the seasonal pattern in the residual entry. Even though, as noted in section 3.1, a seasonal pattern is probably inevitable in the residual entry, this F ratio is even lower than that of 5.4 found in Table 2 for the residual entry after the second round of seasonal adjustment. This result supports the multiplicative adjustment of levels as an adequate new method of seasonal adjustment of the growth of the money supply and its causes. Finally, we note that the standard deviation of the residual entry – as shown on the last line of Table 5 – has been reduced slightly in comparison with that obtained with the method used so far (where it amounted to nearly Fl. 350 million).

In the construction of series of levels the problem arises which level must be taken as the basis. The changes in the counterparts of the money supply must logically be equal to the causes of money growth. This is not always the case because of breaks in series and, as far as net foreign assets are concerned, because of revaluations of the gold and foreign exchange holdings. For net foreign assets, the difference between the series based on the initial level and that based on the final level is Fl. 5,633 million. It was investigated whether this difference has a strong

Table 5 **Analysis of seasonal adjustment by means of the standard method**

Description	Standard adjustment	
	$\bar{I}/\bar{S}$	F
Money supply	0.52	68.9
Public-authority floating debt	0.45	70.8
Net money-creating operations	0.66	35.5
Net foreign assets	1.39	2.7
Miscellaneous items (net)	0.38	92.2
Residual entry	0.72	3.4
Standard deviation of residual entry (millions of guilders)	308	

Explanatory note: Based on monthly figures for the twelve-year period 1968-1979.

effect on multiplicative seasonal adjustment [16]. This proved not to be the case. The choice between initial level and final level (or an intermediate level) as the basis for the series of levels is therefore of no importance from the angle of seasonal adjustment. For all counterparts of the money supply, the initial level was chosen.

3.3. Net money-creating operations

In its monetary analysis, the Bank traditionally breaks down the net money-creating operations into a number of components; the method of seasonal adjustment used so far adjusted these components separately. In the revised method, these components are seasonally adjusted in connection with the adjustment of total net money-creating operations. In principle, the same problem arises here as in the seasonal adjustment of the money supply and its counterparts. This problem is again solved as described in sections 2 and 3.2.

In the revised method, the net money-creating operations are adjusted multiplicatively. Thus, the various components, viz. short-term bank lending to the private sector, mortgage lending, other long-term lending, genuine savings and other long-term liabilities, should also be adjusted multiplicatively on the basis of levels. To check whether this preference for multiplicative adjustment as opposed to additive adjustment is supported by empirical evidence, trend regressions of specification (3.1) were estimated for the five sub-series mentioned above. The results in Table 6 confirm that for all series multiplicative adjustment is to be preferred.

[16] In the case of additive adjustment, addition of a constant term has no effect.

Table 6 **Estimation results of the trend regressions for the components of net money-creating operations**
(millions of guilders)

Description	Constant (α)	Trend coefficient (β)
Short-term bank lending	62 (1.48)	0.008 (6.21)
Mortgage lending	1 (0.03)	0.006 (8.99)
Other long-term lending	7 (0.24)	0.006 (6.31)
Genuine savings	–15 (0.18)	0.012 (4.92)
Other long-term liabilities	–2 (0.08)	0.016 (11.14)

Explanatory note: Based on monthly figures for the twelve-year period 1968-1979. The t-values are shown in parentheses.

Table 7 presents the $\overline{I}/\overline{S}$ and F ratios resulting from this adjustment. Except for other long-term lending, the F ratios show a significant seasonal pattern for all components, while the $\overline{I}/\overline{S}$ ratios of these series are smaller than one. This indicates a reliable estimate of the seasonal component of these four sub-series.

Measured by the standard deviation, the monthly average of the residual entry for net money-creating operations is Fl. 151 million. A notable feature is the F ratio of 8.0, which means that the residual entry still contains a marked seasonal pattern. This may be a consequence of the fact that the series of net money-creating operations has been disaggregated into a relatively large number of components.

In the procedure of distributing the residual entry balancing the adjusted money growth and its causes, a part of this entry has been allocated to the seasonally adjusted series of net money-creating operations. The standard deviation of this part is Fl. 74 million. Together with the residual entry resulting from seasonal adjustment of the components of the net money-creating operations, this part of the residual entry arising from the original balancing problem must be distributed among the components of the net money-creating operations. The distribution of this composite residual entry, whose standard deviation of Fl. 150 million is surprisingly not larger than that of the residual entry for the net money-creating operations themselves, is again carried out in accordance with the procedure outlined in section 2 above.

Table 7 **Analysis of multiplicative seasonal adjustment of the components of net money-creating operations**

Description	$\overline{I}/\overline{S}$	F
Short-term bank lending	0.94	6.0
Mortgage lending	0.69	32.2
Other long-term lending	1.63	0.9
Genuine savings	0.58	46.9
Other long-term liabilities	0.71	51.1
Residual entry (additive)	0.47	8.0
Standard deviation of residual entry (millions of guilders)	151	

Explanatory note: Based on monthly figures for the twelve-year period 1968-1979.

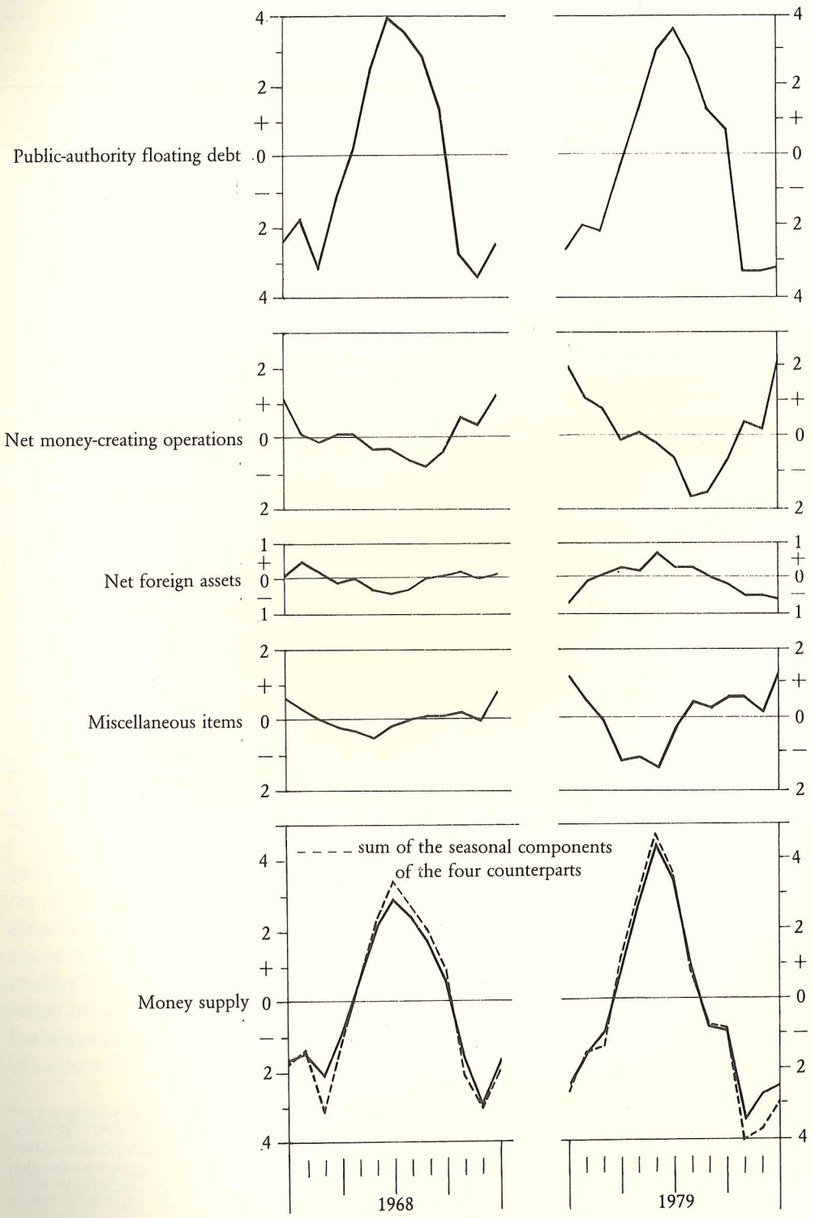
4. Analysis of results

This section presents and analyses the results for the seasonally adjusted series of the monetary analysis after application of the new, uniform adjustment method and the procedure to distribute the residual entry. The discussion is mainly based on graphic inspection of the series [17].

Chart 2 gives the seasonal components for the years 1968 and 1979 for the money supply and its four counterparts before distribution of the residual entry, expressed as percentages of the money supply. The Chart shows that the seasonal components resemble each other closely in these two years. The most notable feature is the high degree of similarity in pattern and in size of the seasonality of the money supply and public-authority floating debt. Apparently, the seasonal pattern of the money supply is, on balance, largely the same as that of public-authority finance.

[17] The monthly data used in this study are made available on request.

Chart 2 **Seasonal components of the money supply and its counterparts**
(before distribution of the residual entry; % of money supply)



The Chart also illustrates that the seasonal components of the four counterparts of the money supply do not sum to the seasonal components of the money supply itself. Consequently, this also applies to the first differences of these seasonally adjusted levels, viz. the causes of money growth.

Using the procedure of distributing the residual entry, the schedule of Table 1 with the adjustment terms has been completed in Table 8 for 1968 and 1979. As can be seen from this Table, the distribution of a residual entry sometimes results in adjustment terms with different signs [18].

Table 8 **Distribution of the residual entry using the standard method for the years 1968 and 1979**
(millions of guilders)

Description	1968 I	1968 II	1968 III	1968 IV	Total 1968	1979 I	1979 II	1979 III	1979 IV	Total 1979	Standard-deviation
Liquidity creation on behalf of public authorities	8	118	19	−145	0	322	99	119	−540	0	166
Change in net money-creating operations	30	19	−40	−9	0	99	−68	−174	143	0	74
National liquidity surplus	−12	43	−9	−22	0	4	138	−4	−138	0	66
Miscellaneous	25	10	−23	−12	0	45	27	−60	−12	0	53
Residual entry	51	190	−53	−188	0	470	196	−119	−547	0	308

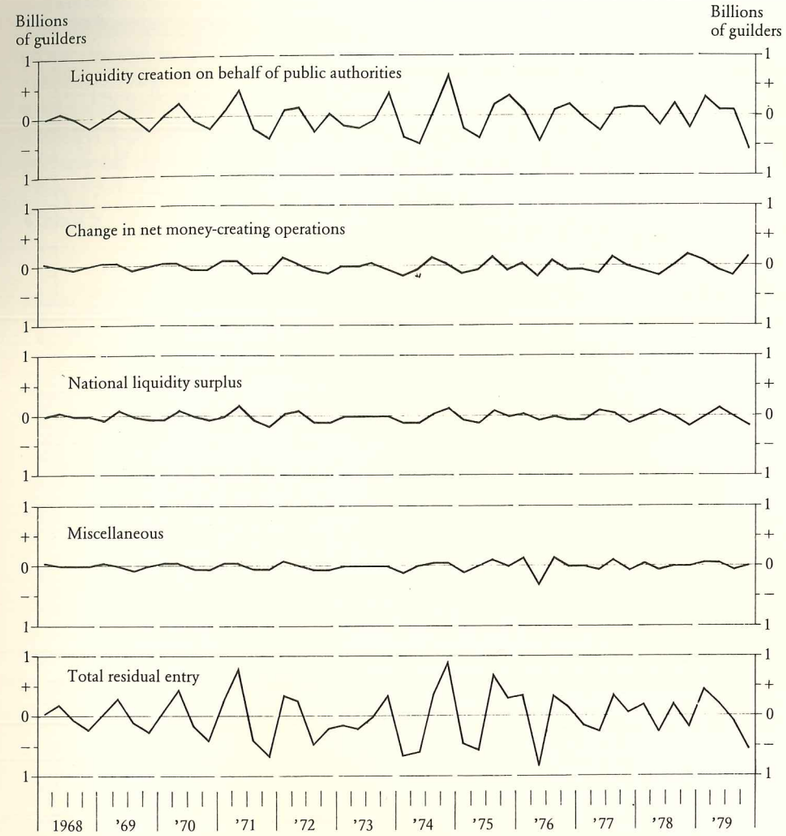
Explanatory note: The standard deviation of the adjustment terms is based on monthly figures for the twelve-year period 1968-1979.

The last column of Table 8 contains the standard deviations of the residual entry and this entry's distribution among the causes of money growth, calculated for the sample period 1968-1979. The Table clearly shows that liquidity creation on behalf of public authorities, on account of the relatively large variability of its seasonal fluctuations, is allocated by far the largest part of the residual entry. On average, the adjustment terms for the other three causes are about the same size.

Chart 3 depicts the residual entry and its distribution among the causes of money growth for the entire sample period. The part allocated to liquidity creation on behalf of public authorities shows by far the largest fluctuations, which closely resemble the total residual entry itself. It is interesting to note that in the first four years of the sample period the residual entry shows a distinct seasonal pattern with gradually increasing fluctuations. After these years, this conspicuous systematic pattern disappears. Coincidentally, for 1979 the pattern of the residual entry is again similar to that for the first four years.

[18] This is mainly due to the grouping of monthly figures (with positive and negative residual entries) into quarterly figures. However, monthly figures, too, show this phenomenon from time to time. It is caused by large differences in the values of the weights and by the constraints that the adjustment terms for each cause must sum to zero over the year. In the course of a year, when all data are not yet available, the residual entry for a quarter or a month is distributed using the weights for the corresponding period of the preceding year. In that case the adjustment terms all have the same sign, as the constraint just mentioned cannot yet be met.

Chart 3 **Distribution of the residual entry among the four causes of money growth using the standard method**

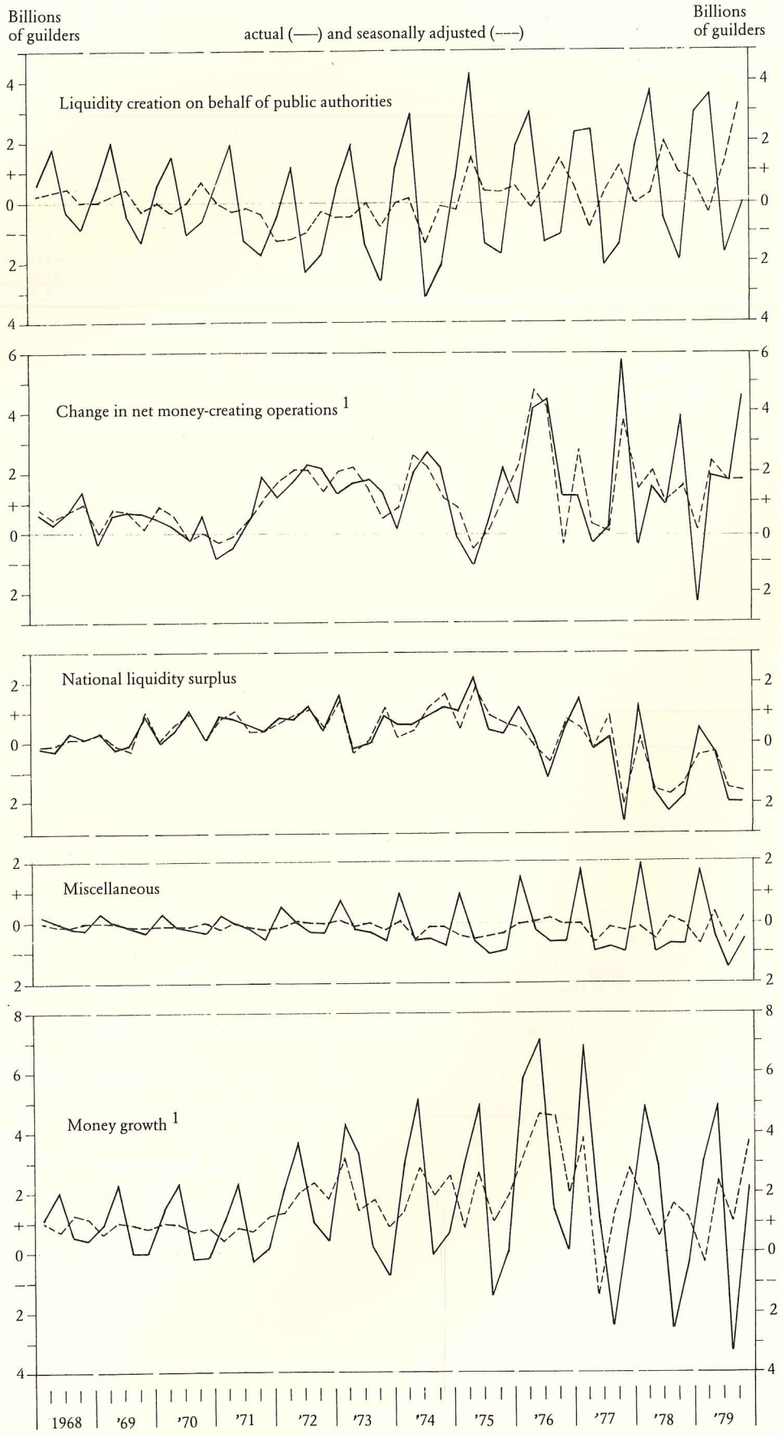


The final result for the adjusted quarterly data on the causes of changes in the domestic money supply as produced by the revised method of seasonal adjustment and the procedure for distributing the residual entry is shown, together with the original series, in Chart 4 (for the period 1972-1977, the series have been adjusted for interest rate induced shifts between savings accounts and time deposits). Notably in the case of liquidity creation on behalf of public authorities and miscellaneous items, seasonal adjustment proves to remove a large part of the actual fluctuations. For the other items, this is much less so.

For the last few years, the seasonally adjusted series for the public authorities shows a pattern which is somewhat contrary to that of the original figures. This could suggest overestimation of the seasonal pattern for recent years, which might be accounted for by the use of the multiplicative method in a situation of sharply rising levels of floating debt. An analysis of this phenomenon is given in the Appendix.

The fluctuations of total liquidity creation appeared to be mainly of a seasonal character in the first years of the sample period. However, since 1973, the movements in these series seem rather large, even after seasonal adjustment. This is especially due to the irregular variations in net money-creating operations. As

Chart 4 **Causes of changes in the money supply**
(after distribution of the residual entry)

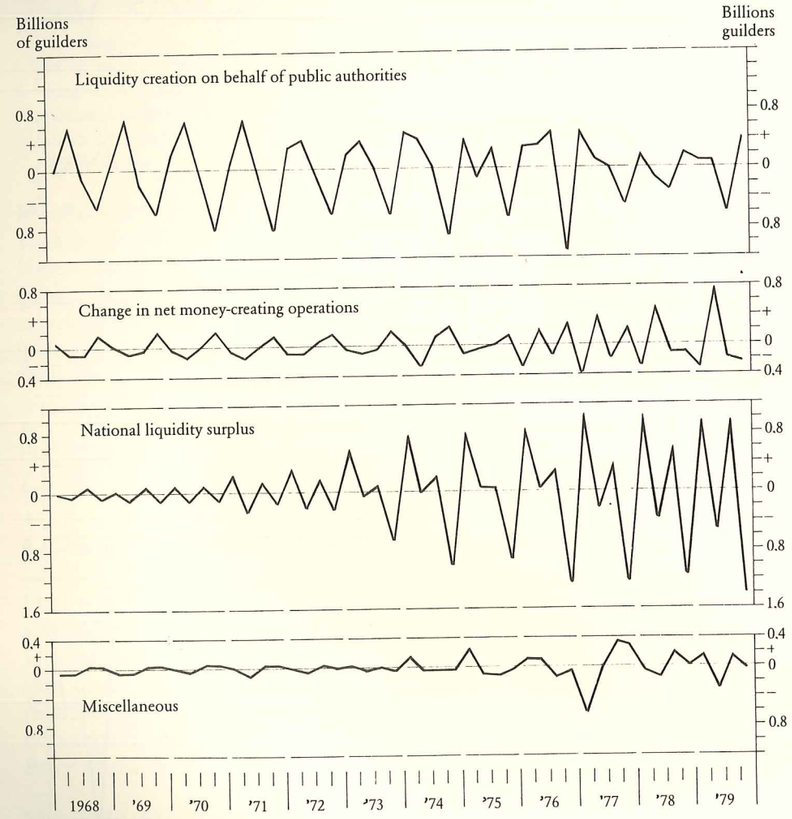


[1] For the period 1972-1977 adjusted for shifts of funds between savings accounts and time deposits.

noted before, the seasonal pattern of the money growth runs largely parallel with that of public-authority finance.

The differences between the seasonally adjusted causes of money growth obtained by the old method of adjustment and those obtained by the revised method are presented in Chart 5 [19]. The Chart shows that the largest differences occur in the case of liquidity creation on behalf of public authorities and in the case of the national liquidity surplus. In the latter case these differences are only apparent in the second part of the sample period.

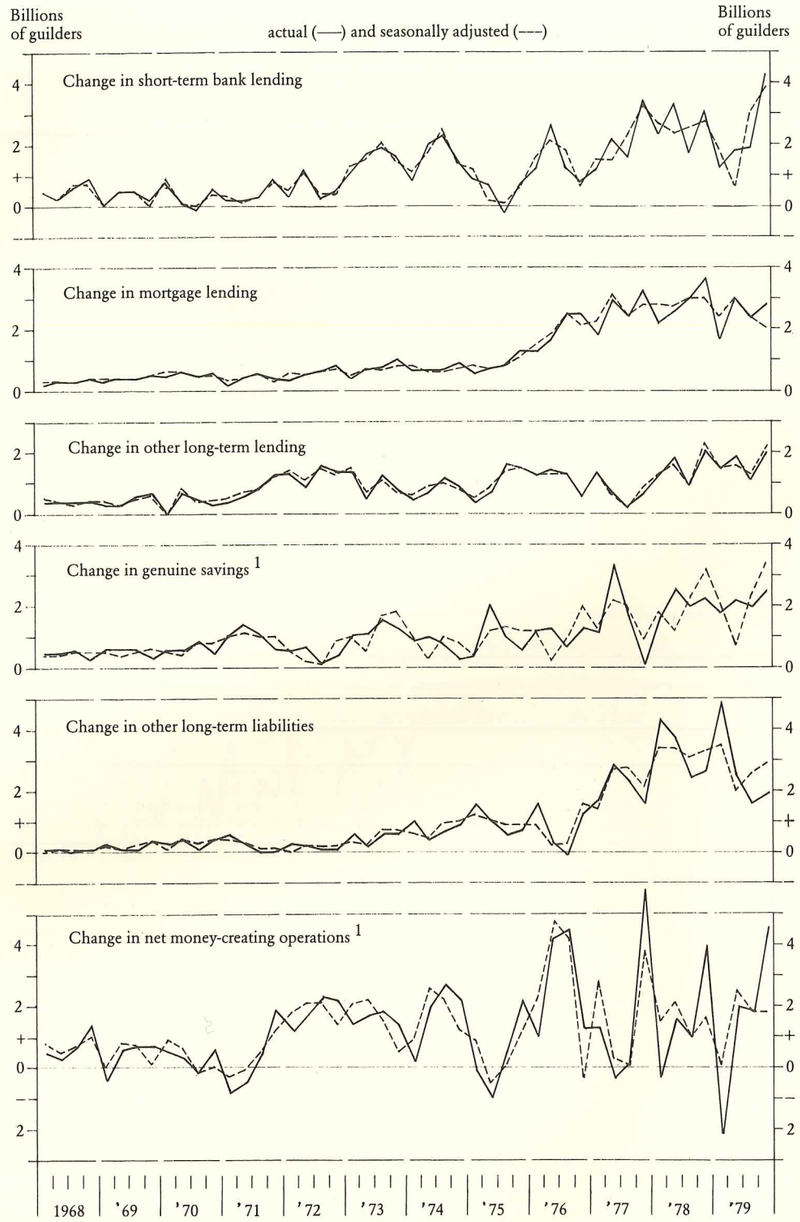
Chart 5 **Difference between the old method of seasonal adjustment and the revised method**



The seasonally adjusted figures for the net money-creating operations and their components, after distribution of the residual entry – this entry also contains the part of the residual entry balancing the adjusted money growth and its causes, which has been allocated to net money-creating operations – have been plotted in Chart 6. Seasonal influences within the net money-creating operations are shown to play a role mainly on the liabilities side, i.e. for both genuine savings and other long-term liabilities. On the assets side, the seasonal fluctuations centre on mortgage lending and, to a lesser extent, on short-term lending to the private sector.

[19] As the two methods do not differ essentially as far as the money supply is concerned, this series is not included in Chart 5.

Chart 6 **Components of net money-creating operations**



[1] For the period 1972-1977 adjusted for shifts of funds between savings accounts and time deposits.

The combination of the seasonally adjusted figures for the four causes of money growth and the components of net money-creating operations results in Table 9, where for 1979 and the first three quarters of 1980 the relevant quarterly data for the monetary analysis are given.

Table 9 **Causes of changes in the domestic money supply**
(millions of guilders)

Description	1979	Oct. '79/ Sept. '80	1979				1980		
			I	II	III	IV	I	II	III
Liquidity creation on behalf of public authorities	5,100	7,900	800	–300	1,300	3,300	500	950	2,600
Short-term bank lending to private sector	9,300	8,400	1,800	600	3,000	3,900	1,650	1,400	1,900
Net long-term operations of money-creating institutions	–3,100	–2,750	–1,700	1,900	–1,250	–2,050	1,350	400	–2,800
of which:									
– mortgage loans	9,850	9,500	2,400	3,050	2,350	2,050	4,000	2,050	1,350
– other medium and long-term lending	6,550	3,100	1,500	1,600	1,250	2,200	200	–500	1,000
– genuine savings (–)	–8,500	–8,100	–2,100	–700	–2,300	–3,400	–2,500	–150	–2,000
– other long-term liabilities (–)	–11,000	–7,250	–3,500	–2,050	–2,550	–2,900	–350	–1,000	–3,150
Miscellaneous [1]	–750	–1,250	–750	450	–650	200	–400	–	–800
Total domestic money creation	10,550	12,300	150	2,650	2,400	5,350	3,100	2,750	900
National liquidity surplus	–3,800	–6,150	–450	–250	–1,450	–1,650	–3,200	450	–1,450
Changes in the domestic money supply	6,750	6,150	–300	2,400	950	3,700	–100	3,200	–550
(percentage increase on an annual basis)	(7.0)	(6.1)	(–1.3)	(9.7)	(3.9)	(14.6)	(–0.4)	(12.1)	(–2.0)

[1] Adjusted for fluctuations in items in transit.

5. Summary and conclusions

The Netherlands Bank performs its analysis of monetary trends on the basis of seasonally adjusted figures. Seasonal adjustment is carried out by the Census X-11 method. As the seasonal components of the causes of money growth do not sum to the seasonal component of the money growth itself, a residual entry results between the adjusted figures of these key series in the monetary analysis; occasionally, this entry assumed relatively large values. Moreover, the residual entry displayed a marked residual seasonal pattern.

The study showed that this residual seasonality in the residual entry generally increases with increasing disaggregation. In the revised method of adjustment, described in this article, each of the four counterparts of the money supply is seasonally adjusted in a uniform manner and without further disaggregation. Subsequently, the residual entry, which is unavoidable when using the Census X-11 method, is distributed among the counterparts by means of a procedure presented in this article. The distribution follows from minimizing the weighted sum of squares of the adjustment terms, subject to the constraints that the adjustment terms for each quarter must sum to the residual entry and that the adjustment terms for one sub-series must sum to zero over the year.

The same method is used for seasonal adjustment within net money-creating operations. Here, too, there is the problem that the seasonal components of the parts

do not sum to the seasonal component of the total, which is solved in an analogous way.

When developing the new method, two questions arose, viz. whether the adjustment should be made on the basis of balance-sheet positions (i.e. levels) or on the basis of the first differences of those balance-sheet positions (i.e. flows) and whether the additive or the multiplicative version of the Census X-11 method was to be used. As to the former, an adjustment of balance-sheet positions was chosen both for theoretical reasons and on practical grounds. As to the latter, regression analysis showed that, with only a few exceptions, multiplicative adjustment was to be preferred.

This revised method of seasonal adjustment causes the residual entry to contain only a minor seasonal pattern. Liquidity creation on behalf of public authorities, whose seasonal pattern closely resembles that of the money supply, is allocated a relatively large part of the residual entry, without any substantial effect on its seasonally adjusted results, however. For all series the fluctuations after seasonal adjustment are smoothed somewhat, but they do not disappear.

The revised method is attractive since it is simple and consistent. It is a purely mechanical method, in which the specific economic nature of the series does not play any role. Therefore, there will be times when this method – like, for that matter, less mechanical ones – produces results which do not seem plausible considering economic developments. In such instances, the results must be assessed in the light of the specific knowledge available about the series.

These problems may arise in the seasonal adjustment of liquidity creation on behalf of public authorities and the national liquidity surplus. In both cases, a series of levels which itself shows a fluctuating trend is adjusted multiplicatively. As described in the Appendix, the series for the public authorities – viz. floating debt – has risen sharply in the past few years owing to substantial liquidity deficits. This rise may temporarily lead to overestimation of the seasonal pattern. The opposite may happen for the national liquidity surplus, whose level – net foreign assets (including gold) of the Netherlands Bank and the banking system – has been falling since 1977 owing to substantial balance-of-payments deficits.

Should such problems lead to an *ad hoc* adaptation of the method of seasonal adjustment it is of major importance that such an adaptation should be seen as a deviation from a standard which adjusts the series in question in a uniform and coherent way. The method described in this article provides such a standard.

Appendix

Liquidity creation on behalf of public authorities

Analysis of the old method of seasonally adjusting the causes of money growth showed that disaggregation and non-uniform adjustment of either balance-sheet positions or flows of funds causes increased seasonality in the residual entry. For that reason the revised method adjusts each of the four causes of money growth without further disaggregation. As far as liquidity creation on behalf of public authorities is concerned, this choice implies adjustment of floating debt[20]. Subsequently, a multiplicative adjustment was chosen. As public-authority revenue and public-authority expenditure exhibit different seasonal patterns, seasonal adjustment of each of these separate flows of funds would seem more logical for the adjustment of this cause of the money growth, when viewed apart from the other causes. In this Appendix the variants referred to are compared and commented upon.

1. Additive or multiplicative

Chart A shows the profile of the trend-cycle component of the levels of floating debt outstanding during the sample period. The Chart clearly illustrates the fall in the period 1971-1974 owing to the substantial destruction of liquidity by the public authorities in these years. However, a high level of liquidity creation has led to a sharp rise in the outstanding amount over the past few years.

In section 3.2 it was noted that the temporary fall in the trend in the early seventies has probably caused the coefficient of the trend term of the regression to be

[20] Floating debt comprises net central government floating debt and gross local authority floating debt.

Chart A **Trend-cycle component of public-authority floating debt**

equal to zero. This is confirmed by the fact that the trend coefficient does become significant and positive when the absolute values of the deviations from the trend are correlated with a simple time trend. The main reason for a multiplicative adjustment of floating debt was uniformity.

In section 4 it was mentioned that, owing to the sharp rise in public-authority floating debt in recent years, multiplicative adjustment may give rise to overestimation of the seasonal fluctuations. After all, if the trend shows a sudden sharp rise and the amplitude of seasonal variation falls short of this rise, the slowness of the Census X-11 method in responding to changes in the seasonal pattern causes the seasonal fluctuations to be overestimated. This problem does not arise if the series of levels is adjusted additively. In that case there is no interdependence between seasonal component and trend, be it that even with additive adjustment the seasonal components may increase over time.

The results of the trend regressions presented in Table A show that, in the case of seasonal adjustment of the flows of revenue on the one hand and the flows of expenditure on the other, multiplicative adjustment is to be preferred.

Table A **Estimation results of the trend regressions**
(millions of guilders)

Description	Constant (α)	Trend coefficient (β)
Public-authority revenue	159.7 (1.23)	0.115 (4.69)
Public-authority expenditure	76.7 (0.87)	0.071 (4.59)

Explanatory note: Based on monthly figures for the twelve-year period 1968-1979. The t-values are shown in parentheses.

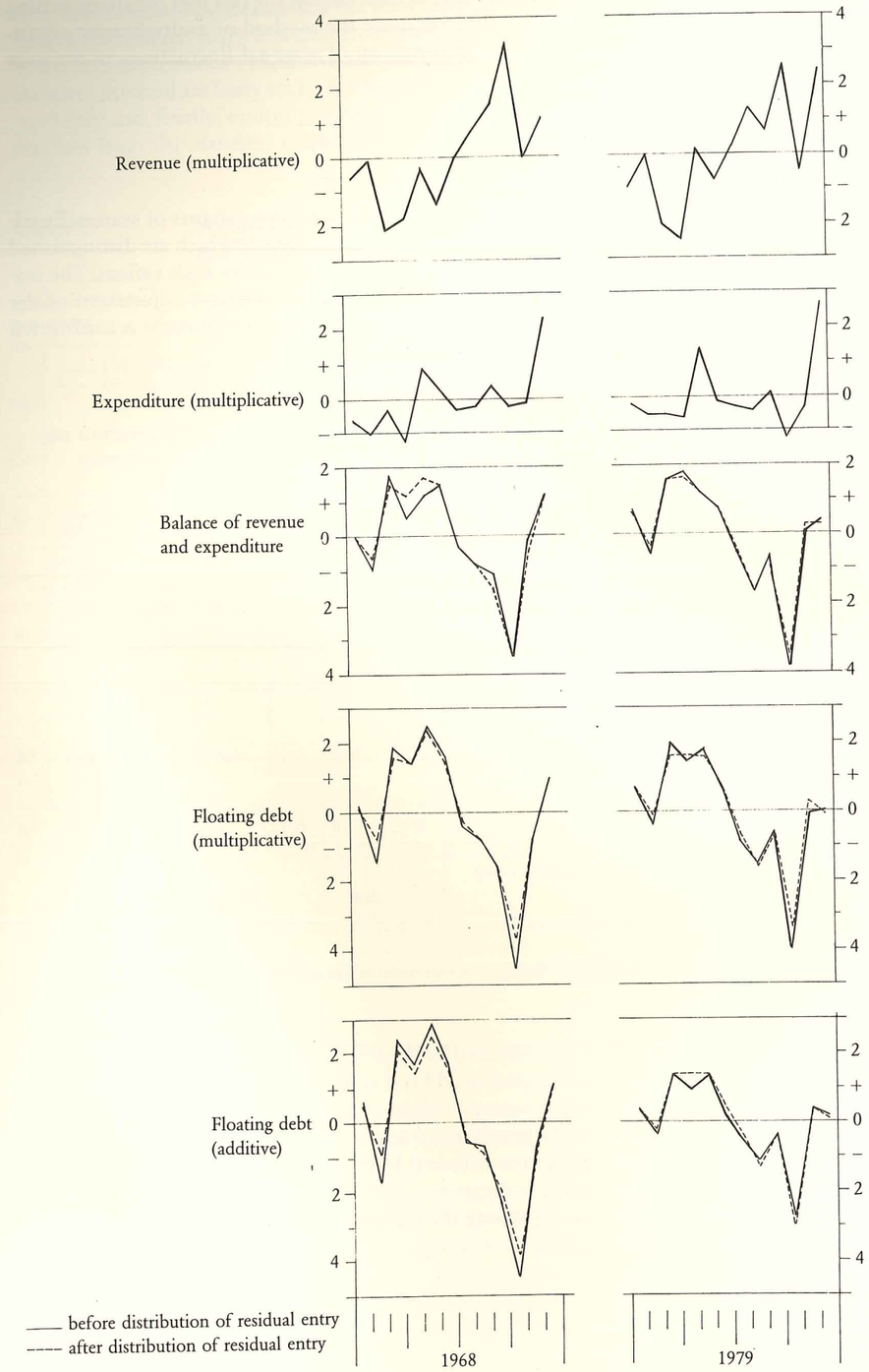
2. Seasonal patterns

Chart B contains a graphic representation of the multiplicative seasonal patterns of public-authority revenue, public-authority expenditure and the balance of the two. The Chart, moreover, shows two graphs with the multiplicative (standard method) and additive seasonal patterns of floating debt [21]. Just as in Chart 2, the seasonal components are expressed as percentages of the money supply.

For 1968 multiplicative and additive adjustment of the levels of floating debt produce virtually identical results, which moreover do not differ much from the seasonal pattern shown by the balance of the seasonal variations of revenue and expenditure. For 1979, too, this striking similarity of the seasonal patterns produced by the three variants is apparent. However, the amplitude of the seasonal fluctuations resulting from the additive adjustment of floating debt appears to have become smaller relative to the volume of the money supply. On the other hand, both in the case of the corresponding multiplicative adjustment of levels and in the case of the adjustment of the flows of revenue and expenditure, the seasonal fluctuations have remained relatively unchanged. Hence, this adjustment of reve-

[21] For the standard method the pattern of **flows** shown in this Chart corresponds to the pattern of **levels** shown in Chart 2.

Chart B **Seasonal components of liquidity creation on behalf of public authorities, calculated in accordance with three variants**
(% of money supply)



nue and of expenditure, which, as noted before, is probably the most logical procedure for the cause "liquidity creation on behalf of public authorities" if viewed independently of the other causes, lends support to the choice for the multiplicative variant for adjusting the level of floating debt within the framework of monetary analysis. This does not, of course, change the fact that the sharply rising series of levels of floating debt may cause the method of multiplicative adjustment to lead to temporary overestimation of seasonal fluctuations in the near future.

3. Residual entries

The application in the monetary analysis of the three variants of seasonally adjusting liquidity creation on behalf of public authorities which are distinguished in this Appendix gives rise to a different residual entry for each variant. The seasonal pattern of this residual entry in case of multiplicative adjustment of the levels of floating debt is given in Table 5. In Table B this outcome is confronted with the results produced by the two other variants.

Table B **Analysis of seasonal adjustment of liquidity creation on behalf of public authorities and of the residual entry**

Description	Standard adjustment (multiplicative on levels)		Ditto, public authorities, additive		Ditto, public authorities, multiplicative on revenue and expenditure	
	$\bar{I}/\bar{S}$	F	$\bar{I}/\bar{S}$	F	$\bar{I}/\bar{S}$	F
Liquidity creation on behalf of public authorities	0.45	70.8	0.43	105.1	rev. 0.48 exp. 0.66	59.4 35.4
Residual entry	0.72	3.4	0.53	6.0	0.57	9.8
Standard deviation of residual entry (millions of guilders)	308		305		272	

Explanatory note: Based on monthly figures for the twelve-year period 1968-1979.

It is noteworthy that, as evidenced by the F ratio, the seasonal pattern of the residual entry is more pronounced in additive adjustment of levels than in the multiplicative variant. Separate seasonal adjustment of flows of revenue and expenditure causes an even more pronounced seasonal pattern in the residual entry, on account of the disaggregation inherent in this method. On the other hand, the adjustment of flows yields a somewhat smaller standard deviation of the residual entry. However, when appraising these results, most weight must be given to be seasonal pattern of the residual entry.

Finally, Chart B shows that in each of the three variants considered the part of the residual entry allocated to the public authorities is small in comparison with the seasonal component.

4. Results

Chart C illustrates the differences between the seasonally adjusted liquidity creation on behalf of public authorities as obtained by the two variants discussed in this Appendix and as obtained by the standard method, in all cases after distribution of the residual entry. It is clear from the Chart that up to 1977 the differences in the results produced by additive adjustment of levels and by the multiplicative standard method are fairly small. For later years, however, the differences increase markedly and, finally, multiplicative adjustment of revenue and expenditure differs less from the standard method than additive adjustment.

Chart C **Seasonally adjusted liquidity creation on behalf of public authorities**